

SPREAD SPECTRUM SCENE

Number 2

May 1, 1992

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The PCN / PCS, LAN / MAN / WAN and CDMA / TDMA
Monthly Newsletter

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EDITORIAL

What is SSS? - What will it cover? Who Are we?

By Randy Roberts - Publisher

Well, here's our second issue! It is bigger, better and hopefully more interesting than the first hurriedly published issue. Some of our mistakes are corrected in the Bit Error box on page two. Spread Spectrum Scene is a new publication devoted to Spread Spectrum systems. This includes all forms of evolving digital cellular radio, PCN / PCS systems, voice and data communications over CT2, CT3, GSM and other, newer systems. SSS also will cover LAN / MAN / WAN systems for computer to computer digital communications. We are starting out in a newsletter format -- we hope to grow into a full fledged monthly magazine in the next six months. SSS' publisher (- Randy Roberts - KC6YJY / ex WA6BFN) has over twenty two years experience developing spread spectrum communication and navigation systems. My consulting company, RF/Spread Spectrum publishes SSS each month. Our editor, Kim Robinson (KM6OH) is our resident software Guru with almost 20 years application software development experience and is also a

BEGINNER'S BOX

What is Spread Spectrum, anyway?

Spread Spectrum uses wide band, noise-like signals. Because Spread Spectrum signals are noise-like, they are hard to detect. Spread Spectrum signals are also hard to intercept or demodulate. Further, Spread Spectrum signals are harder to jam (interfere with) than narrow-band signals. These Low Probability of Intercept (LPI) and anti-jam (AJ) features are why the military has used Spread Spectrum for so many years. Spread signals are intentionally made to be much wider band than the information they are carrying to make them more noise-like.

Spread Spectrum signals use fast codes that run many times the information bandwidth or data rate. These special "Spreading" codes are called "Pseudo Random" or "Pseudo Noise" codes. Because they are not real noise, they are called 'Pseudo.'

Spread Spectrum transmitters use similar transmit power levels to narrow band transmitters. Because Spread Spectrum signals are so wide, they transmit at a much lower spectral power density, measured in Watts per Hertz, than narrowband transmitters. This lower transmitted power density characteristic gives spread signals a big plus. Spread and narrow band signals can occupy the same band, with little or no interference. This capability is the main reason for all the interest in Spread Spectrum today.

See other BEGINNER'S BOXES for more information.

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SPREAD SPECTRUM SCENE

The PCN/ PCS, IAN / MAN /
WAN and CDMA/TDMA
Newsletter

**SSS is dedicated to the
Spread Spectrum
professional and is
committed to be the
primary source for the
latest news and
information about the
growth, regulation and
opportunities in this
emerging science.**

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SSS provides an open forum for publication of technical information, advertising, editorials, opinions and news relating to our dedication statement.

Letters to the editor are welcome. Manuscripts submitted for publication should have a return envelope included if the author wants his originals returned. We will make every endeavor to publish items submitted to us if they are previously unpublished, address our subject area(s) and provide timely, general interest information.

consultant (K&J Computer Systems, Inc.). Our newest staff member, Koert Koelman (KC6WCI) is our Director of Advertising and Circulation. Koert brings over 30 years experience in marketing and business development to SSS. He is a welcome and needed addition to our staff. If we are to grow into a substantial publication we must pay attention to marketing and business issues.

SSS will provide a forum for the exchange of ideas, new product information, free and display advertising and detailed coverage of the rapidly changing regulatory environment.

Our first letters and new product announcements appear in this issue. We also have **some** advertising in this month's newsletter. Several new features appear this month. As the contents sidebar shows, this month starts the serialization of a new book by your Publisher on spread spectrum. This book will be serialized here in the next several issues - it should be available in its complete form sometime in mid summer. This book is intended to update the ubiquitous **Spread Spectrum Sourcebook** from the ARRL as well as to provide a completely independent and up to date alternative to my friend, Bob Dixon's book **Spread Spectrum Systems**. Don't forget Technical Tricks - this month covering Gold codes. In addition, a short paper on SS propagation and range measurements starts in this month's issue.

SSS will provide a forum for the exchange of ideas, new product information, free and display advertising and detailed coverage of the rapidly changing regulatory environment.

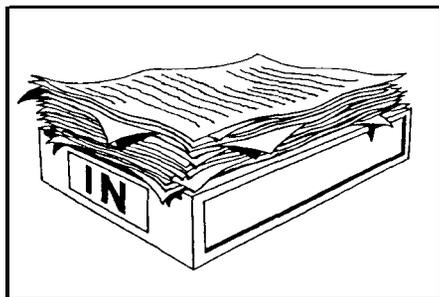
Please send us your comments and criticisms -- good or bad. Your feedback is the only way we know if we are on the right track or not! We really want to encourage reader participation in this newsletter and are planning a dedicated BBS for subscribers only in the near future. This BBS will have late breaking news, draft articles for the next month's issue, reader and special interest forums, a question and answer board, some form of e-mail and possibly an upload / download software capability. What do you think -- should we go forward with an SSS BBS?

We have several new ideas for regular columns that you might like to see, but we need help writing the copy for these columns. Is there anybody out there who may want a FREE subscription to SSS and who is willing to take on a monthly or bi-monthly column? Call us with your ideas for regular columns and to volunteer your help!

We want and need more technical information in these pages - we have several interesting subjects in mind, but we need people to submit new and different articles for publication. We welcome technical articles of any length and at any level of sophistication. Our main requirement is that all articles for publication here must be previously cleared for reprint or must never have appeared in print before. Application notes or other previously published information with accompanying reprint/copyright release are also welcomed. Till June!

BIT ERRORS

- In our first issue, the article on the Ham STA used the acronym TAPAR incorrectly. *This fine organization is called:* TAPR.



LETTERS & COMMENTS

Comment from Mr. James R. Hendershot, WA6CQP, Principal Engineer at Radio Design Group, Grants Pass, Oregon:

Page 3 says: "... Gold (or Dr. Robert Gold of JPL codes - sometimes called Ranging) codes." This implies that Gold codes & JPL ranging codes are the same, which they are not. Careful, please!

Mr. Hendershot is perfectly correct. Thank you, James - I was a little too loose with that parenthetic reference. I stand corrected.

Excerpt from a nice long letter from Mr. David Cassidy - NIGPH, Associate Publisher of 73 Amateur Radio Today:

... Congratulations on the first issue of SSS. Every new technology needs a publication to make it popular. Maybe SSS will do that for Spread Spectrum.

Thanks for the nice words, David. David, thanks, also, for your constructive business oriented comments.

Excerpt from a letter from Mr. Ed Hajny, W6ACW, of BOOKS etc.:

Enclosed is a check for my subscription to help with your newsletter.

On a trip to the L. A. area, the monthly TRW swap meet, the newsletter drew some but not a lot of attention. ... A possible suggestion is that a short description of what spread spectrum is, ... might help. ... Like my own self, most hams at a swap meet know practically nothing about it. ...

Thanks for the nice letter (and your subscription) Ed. I have taken your suggestion to heart -- see the BEGINNER BOXES in this and forthcoming issues. (By the way -- Ed is our first Dealer / Distributor, he attends about seven swap meets a month in California and Arizona -- look for him.) Thanks, also, for the business related comments, Ed.

Letter from B. Giora Goldberg, Vice President of Engineering and Chief Technical Officer of SCITEQ, San Diego:

It was good to see you (at RF EXPO WEST), and let me first wish you good luck with the Newsletter.

Here is an article that might be of interest. We'll gladly sign up. What is your FAX number?

Thanks Giora, for the nice sentiments, Our FAX is 510-278-7482. Giora enclosed a paper that he wrote in 1980, entitled "Code Division Multiplexing by Frequency Shifted Biphasic Modulated M-Sequences," available for \$.75 from the IEEE reprint department. Thanks for the reprint Giora -- do you have anything newer and not yet published, even a short note? Send it to me and you will see it here!

Excerpt from a FAX from Dewayne Hendricks, President of Tetherless Access, Ltd., Fremont:

Thanks for the copy of your newsletter, Spread Spectrum Scene that I received in the mail. It is good to see that you have started the newsletter. I wish you

luck with it. ...

Thanks, very much, Dewayne. Nice to hear from you. Dewayne (and Bob Buaas) however, took a great deal of exception to the feature last month on the Ham Radio STA. They have furnished me with more information, which is reprinted below in this month's continuing saga of the Ham STA.

BEGINNER'S BOX

Recommended For Your Bookshelf

(1) **THE ARRL SPREAD SPECTRUM SOURCEBOOK**, The American Radio Relay League, 1991.

(2) *Spread Spectrum Systems*, Robert C. Dixon, Second Edition, 1984, John Wiley & sons.

(3) *Solid State Design FOR THE RADIO AMATEUR*, Wes Hayward and Doug DeMaw, The American Radio Relay League, 1986.

(4) **THE ARRL UHF/MICROWAVE EXPERIMENTER'S MANUAL**, The American Radio Relay League, 1990.

(5) *The Theory and Practice of Modern Design*, John A. Bingham, John Wiley & Sons, 1988.

(6) *Frequency Synthesizers -- Theory and Design*, Vadim Manassevitch, John Wiley & Sons, 1987.

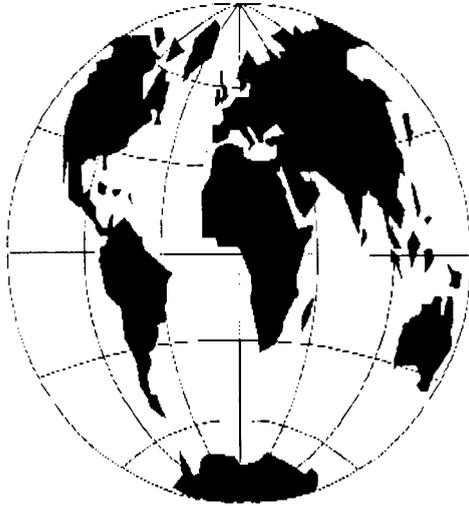
(7) *Digital Communications -- Satellite /Earth Station Engineering*, Dr. Kamilio Feher, Prentice-Hall, Inc., 1983

(8) *Digital Satellite Communications*, Tri T. Ha, Macmillan Publishing Company, 1986.

(9) *Antennas*, John D. Kraus, McGraw-Hill Book Company, 1988.

(10) *Phaselock Techniques*, Floyd M. Gardner, John Wiley & Sons, Inc., 1966.

Put SSS on your Bookshelf!



International Scene

This month we bring you some choice tidbits from across the world:

From an article entitled "Intelsat upon," in the February 22, 1992 edition of *THE ECONOMIST*: "For proof of the stupidity of much in international telecoms regulation, look at the history of Columbia Communications, a tiny satellite firm based in Hawaii. Columbia signed up its first customer a few weeks ago, nearly three years after it first tried to launch a service. The process took that long not because of lack of demand for Columbia's wares, nor because of a lack of satellite capacity, but because of an endless tangle of red tape and the opposition of Intelsat, the consortium of 121 national telephone companies that clings to a virtual monopoly of the transmission of satellite signals between continents."

This interesting inset on page 65 goes on: 'Given Columbia's story, it is unsurprising that few other firms have tried to break Intelsat's grip. Only one other independent satellite company, Alpha Lyracom, transmits signals across the Atlantic, and nobody but Intelsat and Columbia has a transpacific service. Orion, a privately-owned consortium planning to launch a satellite over the Atlantic in 1994, took four years to win the necessary permission. Anyone planning to follow in Columbia's footsteps had better call his lawyer first.'

Another quote from the February 22, 1992 *THE ECONOMIST*: 'Four years ago the European Commission cracked open the EC market for telephone equipment. Two years ago it did the same for information services delivered over the telephone wires. This year the liberalisers are creeping up on the telecoms industry's innermost citadel—ordinary voice telephony. Expect a battle royal.'



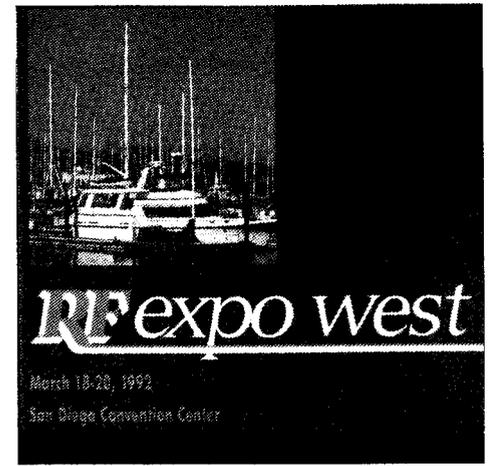
Hot off the press of the WSYI Report are the following useful items:

"FCC Shifting Focus to Causes of RFI and TVI"

"Drastic reductions in federal spending have prompted the FCC to change its approach to dealing with local radio-frequency interference (RFI) and television interference (TVI) complaints. Individualized, on-site help from FCC public service staff will be more difficult to obtain. On the other hand, the FCC is apparently raising its expectations of industry to manufacture products that are more immune to interference. Amateurs who are often unfairly blamed for interfering with susceptible consumer devices should **welcome this** change, if it brings real results.

'Rather than investigating individual cases of interference to home appliances, the FCC is redirecting its resources to appliance manufacturers, exploring possible future regulatory action, and taking other steps to reduce the likelihood that interference will occur in the first place,' according to FCC Baltimore Engineer-in-Charge (EIC) Robert Mroz, in a standard letter sent to RFI complainants."

... "New European regulations -- to be in force throughout the European Community nations -- require electronic products to demonstrate an "adequate level of intrinsic electromagnetic immunity" from outside interference."



Cover Art Courtesy RF EXPO WEST

RF Expo Report

Your publisher attended the RF EXPO West last month -- it seemed like a great success. Though the aisles were never crowded, it was well attended.

Mr. Tony Cieri, Vice President of Sales at Sage Laboratories said of the show: "It was very good the first two days -- but a show like that should not end on Friday. The technical quality of the show was excellent."

Mr. Randy Rhea, Founder and President of Eagleware, had the following remarks to make about the Expo: "It was a very good show! The traffic was light but the technical quality was very high. Eagleware closed **more sales at this show than any previous show it has ever attended, including prior RF Expo's and MTT's.**"

See RF Expo on page 10

June SSS Preview

Technical Tricks: More on Gold Code PN generators plus all about serial correlators, what they do and how to build a sliding one.

Special: Second installment of *Introduction to Spread Spectrum*

Interesting: Contributed articles of interest to all.

Random Bits: More on SSS propagation.

More on Ham Radio SS STA

by Randy Roberts

Dewayne Hendricks and Bob Buas attended the Peninsula Packet Radio Society (now unofficially known as the High Tech Experimental Radio Club) meeting, on April 8, 1992. In an informal chat, Bob straightened this writer out about some details on the STA. Bob said "The STA has not yet been formally approved by the FCC -- they have verbally Ok'd it, but there is still no official paperwork in our hands." Further questions from this reporter brought Bob to say "No comment."

Dewayne Hendricks provided SSS with the following information about Tetherless Access Limited's plans. The following quote is from Appendix E of Dewayne's paper presented at TAPR in March, 1992. Thanks very much, gentlemen, for the kind co-operation and helpful information.

"San Diego Library Experiment

"CONTINUING DEVELOPMENT OF
CALIFORNIA STATE PACKET
RADIO

"1992 will see dramatic evidence of the return on investment from research and development in the California State Library Packet Radio Project undertaken during the mid and late 1980's. IBM, the Council on Library Resources, and principally the California State Library, all made grants to the University of California where Dr. Edwin Brownrigg was the principal investigator in a series of projects that explored the potential for packet radio -- wireless, high-speed digital communications -- among libraries.

"While the early goals of the R&D were to demonstrate technological feasibility and to adapt extant FCC (Federal Communication Commission) rules to packet radio technology among libraries, the actual outcome was the need for a fresh approach. The project showed that the conventional radio technology and the standard digital encoding techniques of the time were becoming arcane approaches to achieving the R&D goals. In fact, the FCC was just then introducing into its rules (Title 47 of the Federal Code of Regulations) a new Part, 15.247, which allowed an exotic method of digitizing a radio wave, and which held promise for packet radio. The new FCC rules were a welcomed alternative to the politics of w-cycling Instructional Television spectrum for packet radio.

"Called spread spectrum, this new method of using radio to convey digital information under Part 15.247 presented several advantages for libraries and other civilian users, as well as large technological challenges

to the telecommunications industry. The major advantages were that multiple users could share the same radio spectrum simultaneously, and that within prescribed transmitter power no user license would be required from the FCC. The challenges were to transfer spread spectrum technology from the military sector, where it had been perfected as a means of secure communication, into the FCC-regulated civilian sector, and, at a reasonable price.

"R&D now under way involves a convergence of interest in California among The Memex Research Institute, Tetherless Access, Ltd. and special-interest user groups. Among the latter is the City of San Diego Public Library, which is using packet radio for a 1.54 megabit link among the central and branch libraries and San Diego State University where the public library sub-network gateways to the Internet.

"The Council on Library Resources and Apple Computer, Inc. are the sponsors of the San Diego Packet Radio Project. One of the project's objectives is to prove that FCC Part 15.247 rules will work for libraries. Dr. Edwin Brownrigg of the Memex Research Institute, and Richard Goodram of San Diego State University are the co-principal investigators.

"Tetherless Access, Ltd. and the Memex Research Institute are now seeking funding to deploy a network of some 600 packet radios in the San Francisco Bay Area for use by civilian groups, including libraries. This network will extend as far south as San Jose and north-east to Roseville. The network's radios will comply with FCC Part 15.247 as well as with an authorization from the FCC allowing Tetherless Access, Ltd. to apply FCC Part 97 rules (Amateur Radio) for the network backbone.

"Together, the San Diego network and the Bay Area network are intended to demonstrate several technical features of packet radio: wireless wide area telecommunications; high data rates; last-mile access to the Internet; and, communication between such wireless networks through the Internet. They also are intended to demonstrate two precedent-setting public policy features of packet radio: common carrier by-pass for public benefit; and, use of the electromagnetic spectrum, a public good, in support of library service, also a public good.

"Accordingly, the Memex Research Institute is seeking the voluntary participation of Bay Area libraries as nodes in the grant-supported wireless wide-area network. A single packet radio at a library will serve a local-area network within the library and gateway it to the wireless wide-area network extending to the Internet.

Next month (June issue) we will publish the complete text of the Amateur Radio STA --
Thanks again to Dewayne Hendricks.

"For more information, please write to Dr. Edwin Brownrigg, Memex Research Institute, 4 2 2 Bonita Avenue, Roseville CA, 9.5678."

Technical Tricks

by Randy Roberts

We're running a little short of space this month -- so we are going to make this column a little short (sorry about that!) We decided to do a 12 page issue and just squeak under the one ounce limit. Oh well, down to something more interesting to you (hopefully), Gold codes.

Gold code sequence generators are useful because of the large number of codes available for a given code length. Two five stage maximal length shift registers can be combined to generate a family of Gold codes that has 33 members. In addition to their ability to generate large numbers of codes, the Gold codes may be chosen such that the cross correlation between all codes in the same family is uniform and bounded. Thus the Gold codes are very useful for code division multiplexed applications.

The Gold codes can be generated by modulo-2 addition (an EXOR operation) of the outputs from a pair of maximal linear sequence generators of identical lengths and different feedback taps. The code sequences are added chip by chip by synchronous clocking -- use the EXOR output as the output signal.

The simplest way to generate Gold codes, today, is to store an entire Gold code family in a memory element of some kind. An EPROM makes a useful Gold code generator for the shorter length Gold code families. Here are the first several Gold codes of length 31 (5 stage SRG):

```
1100110100100001010111011000111
1011001110000110101001000101111
010100111000100001111101000000
111110101001111111001110100001
1010100010110000010101001100010
0000110011101111001100111100100
```

Next month we will finish listing this 33 member Gold code family, so you can blow an EPROM. And we'll have a schematic and a circuit description.

Learn about Spread Spectrum in SSS!

Introduction to Radio Link Engineering

Short Tutorial: The art (science?) of radio link engineering is reasonably well developed. It bases its predictions upon statistical measurements of typical signal fading characteristics found in varying radio communications environments. The most fundamental principle of this science is the radio range equation. The radio range equation, simply stated, provides a way to estimate the radio range (in miles) possible with different equipment and propagation factors. At VHF and UHF, terrestrial radio links usually are based on radio line-of-sight conditions. Such conditions cause received signal strengths to vary as the inverse range squared. If during range testing, it is found that signal levels are much less than this prediction, then free space line-of-sight conditions do not apply and the actual operative propagation mode is by scatter, diffraction, multipath or refraction. Signal strengths received under these conditions vary in inverse relationship with range to the third through seventh power. In other words, range is greatly reduced if line-of-sight conditions do not exist.

The radio range equation is simply an algebraic sum of various plus or minus factors affecting a radio communication link. Any excess of gains (+ factors) over losses (- factors) gives the so called link margin (or link fade margin). The list of factors entering the equation are (all factors are entered in dB and summed algebraically):

Factor	Comments
- 36.6 dB	: Units conversion factor
- 20 Log (frequency)	: Frequency of operation in MHz
- 20 Log (range)	: Range in miles
+ TX Power in dBm	: Transmitter power level
+ TX Antenna gain	: Transmitter antenna gain
- TX line losses	: Transmitter cable losses
+ RX antenna gain	: Receiver antenna gain
- RX line losses	: Receiver cable losses
+ 196.6 dBm	: Boltzman's constant in Kelvin/Hertz
- 10 Log (noise Temp)	: System receiver noise figure
- 10 Log (data BW)	: Receive data bandwidth in Hertz
- RX threshold	: Receive threshold S/N ratio
- Misc. losses	: Total misc. losses

To use the above range equation either by hand or with a spread sheet, simply sum all factors. If the final sum is positive, then there is some link margin for fading or jamming. If the final sum is negative, the link will not work at all under any conditions.

Terrestrial communication links require a 10 dB fade margin to work reliably 50% of the time. Higher link reliability (link availability) requires the following link margins:

% Availability	Hours Outage per Year	Fade Margin
90	1000	20 dB
99	100	30 dB
99.9	10	40 dB
99.99	1	50 dB

At least two other factors must be considered in link design: antenna heights and Fresnel zone clearance. More on these subjects in June!

Spread Spectrum Radio Propagation

By Randy Roberts

The subject of estimating propagation losses for spread spectrum communications radio range estimation is a fascinating and mysterious one. One recent article in *Communications Quarterly*, Winter 1992 issue by Andy Sharpe, W4OAH¹ casts some needed light on this subject. In this article Andy writes:

'When performing a link analysis to predict the operating range between terrestrial stations, the losses caused by terrestrial effects modify the path-loss factor significantly. Free-space calculations are no longer applicable.'

The article further, provides the following advice:

"Unfortunately, the tendency to use free space propagation and adjust for 'terrestrial losses' still exists among the academia. This results in predicted ranges that often are orders-of-magnitude greater than actual operating

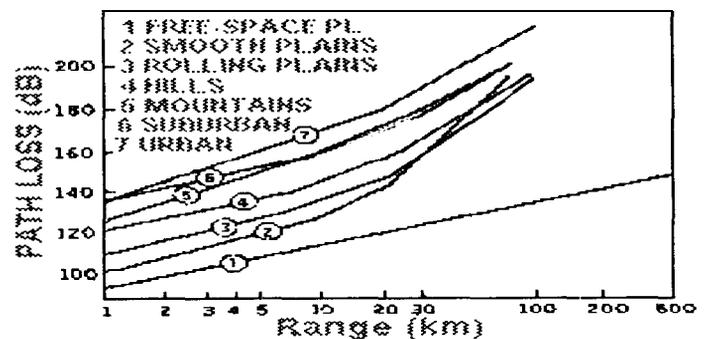


Figure courtesy of CQ Communications, Inc., thanks to Terry Northrup, KA1STC.

ranges encountered when a communications system is finally fielded.*

The "typical" losses seen in SS links at 900 MHz are similar to the figure above, taken from Terry's article. It is seen that so called "excess" path losses of up to 70 dB are possible in real world situations. There are a large number of reasons for the propagation conditions to be so much worse than the "ideal" free space model.

Various real world factors such as antenna height, Fresnel zone clearance, multipath propagation and non-standard atmospheric conditions (like "ducts" that stay there for weeks on end) can cause some of these severe extra propagation losses. Other variable propagation phenomenon can also wreck havoc on your "free space" link calculations. Finally, fading and link reliability must be taken into account -- more on all of these factors next month.

References:

1. Andy Sharpe. 'PROPAGATION LOSSES BETWEEN RANDOMLY LOCATED ANTENNAS AT UHF,' *Communications Quarterly*, Volume 2, Number 1, Winter 1992, pp. 94-98.

INTRODUCTION TO SPREAD SPECTRUM

by R. H. Roberts

First installment of a forthcoming book by the SSS publisher.

Chapter 1 -- Basics

Over the last 50 years, a class of modulation techniques usually called "Spread Spectrum," has been developed. This group of modulation techniques is characterized by its wide frequency spectra. The modulated- output signals occupy a much greater bandwidth than the signal's baseband information bandwidth. To qualify as a spread spectrum signal, two criteria should be met:

1 -- The transmitted signal bandwidth is much greater than the information bandwidth.

Most commercial part 15.247 spread spectrum systems transmit an RF signal bandwidth as wide as 20 to 254 times the bandwidth of the information being sent.

2 -- Some function other than the information being transmitted is employed to determine the resultant transmitted bandwidth.

Most commercial part 15.247 spread spectrum systems transmit an RF signal bandwidth as wide as 10 to 127 times the bandwidth of the information being sent. Some spread spectrum systems have employed RF bandwidths 1000 times their information bandwidth.

Common spread spectrum systems are of the "direct sequence" or "frequency hopping" type, or else some combination of these two types (called a "hybrid").

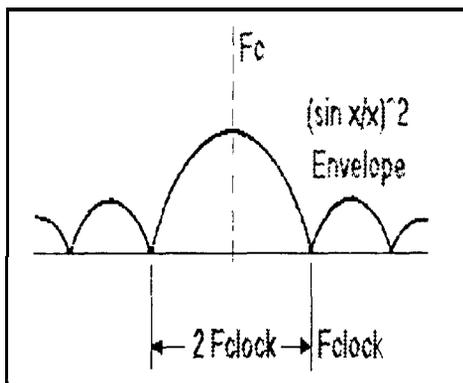


Figure 1: Frequency spectrum of a direct sequence spread spectrum signal.

There are also "Time Hopped" and "Chirp" systems in existence. Time hopped spread spectrum systems have found no commercial application to date. However, the arrival of cheap random access memory (RAM) and fast micro-controller chips make time hopping a viable alternative spread spectrum technique for the future. "Chirp" signals are often employed in radar systems and only rarely used in commercial spread spectrum systems.

Direct sequence systems -- Direct sequence spread spectrum systems are so called because they employ a high speed code sequence, along with the basic information being sent, to modulate their RF carrier. The high speed code sequence is used directly to modulate the carrier, thereby directly setting the transmitted RF bandwidth. Binary code sequences as short as 11 bits or as long as $(2^{89} - 1)$ have been employed for this purpose, at code rates from under a bit per second to several hundred megabits per second.

The result of modulating an RF carrier with such a code sequence is to produce a signal centered at the carrier frequency, direct sequence modulated spread spectrum with a $(\sin x/x)^2$ frequency spectrum. The main lobe of this spectrum has a bandwidth twice the clock rate of the modulating code, from null to null. The sidelobes have a null to null bandwidth equal to the code's clock rate. Figure 1 illustrates the most common type of direct sequence modulated spread spectrum signal. Direct sequence spectra vary

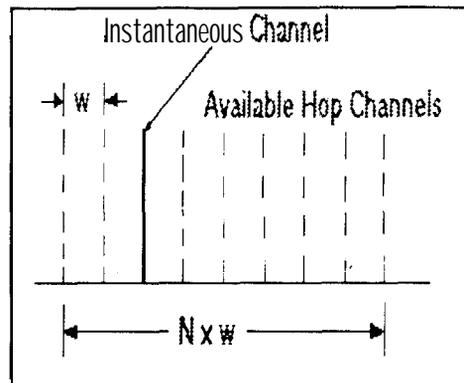
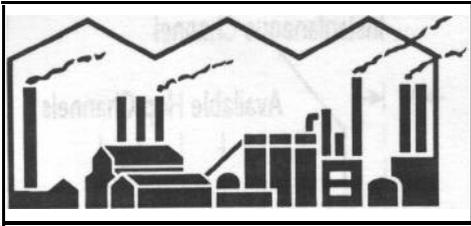


Figure 2: Frequency spectrum of a frequency hopped spread spectrum signal.

somewhat in spectral shape depending upon the actual carrier and data modulation used. The signal illustrated is that for a binary phase shift keyed (BPSK) signal, which is the most common modulation signal type used in direct sequence systems.

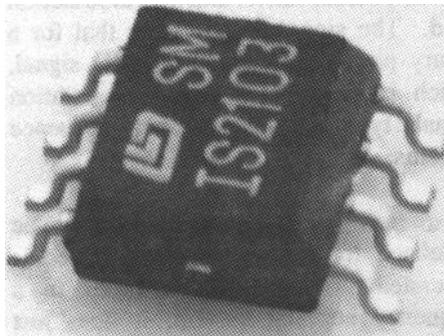
Frequency hopping systems -- The wideband- frequency. spectrum desired is generated in a different manner in a frequency hopping system. It does just what its name implies. That is, it "hops" from frequency to frequency over a wide band. The specific order in which frequencies are occupied is a function of a code sequence, and the rate of hopping from one frequency to another is a function of the information rate. The transmitted spectrum of a frequency hopping signal is quite different from that of a direct sequence system. Instead of a $(\sin x/x)^2$ -shaped envelope, the frequency hopper's output is flat over the band of frequencies used. Figure 2 shows an output spectrum of a frequency hopping system. The bandwidth of a frequency hopping signal is simply w times the number of frequency slots available, where w is the bandwidth of each hop channel.

Chapter 1 concludes next month.



NEW PRODUCTS:

ST Olektron GaAs SPDT Switch



ST Olektron Corporation, 28 Tozer Road, Beverly, MA 019155579 - Telephone 508-922-0019, FAX 508-927-9328 announces the availability of the **SM-IS-2103**, a low cost (\$2.95 in 25 to 1000 piece quantities) **wideband** (DC-2000 MHz) Gallium Arsenide SPDT switch IC. The 8 pin SOIC device is low loss, varying from 0.7 dB at 100 MHz to 0.9 dB at 1000 MHz. VSWR is 1.15:1 maximum and isolation varies from 50 dB at 100 Mhz to 30 dB at 1000 Mhz.

OptaPhone+ & OptaPhone STAR

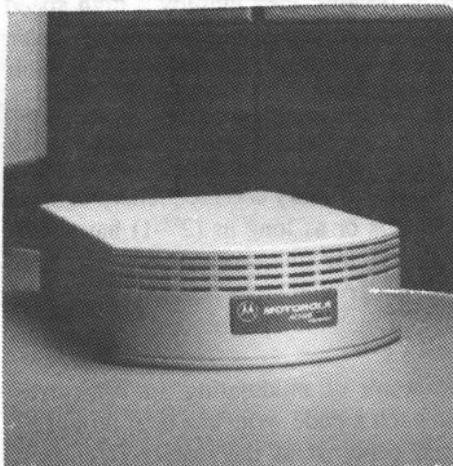
Jim **Carlson**, Chairman of the Board and President of **Carlson Communications**, 655 Redwood Drive, **Garberville, CA 95440** - Telephone 707-923-2911 - FAX 707-923-2655, announces the latest additions to their remote location wireless telephone connect systems. **Carlson** communications supplies sophisticated,

US made systems that use advanced radio technology to connect remote locations to distant phone lines. The **OptaPhone** is not a cellular telephone, but rather part of a complete independent RF communications system. **CCI** also manufactures a line of high specification synthesized telemetry radio modules and RF power amplifiers.

Spectrum Products Inc.

Spectrum Products Inc., 10891 Capital Avenue, Garden Grove, CA 92643-4953 - Telephone 714-554-2166 FAX 714-554-3090 **announces** it's new Low Noise Series of 20 to 2000 MHz, TO-8 oscillators. **SPI** also has available **microwave** oscillators in the 3 to 18 GHz frequency range and TO-8 or surface mount **VCOs**. Other products to be available soon are microwave **DRO's** and phase locked subsystems employing **DRO's**.

ALTAIR PLUS Wireless Networking for Ethernet

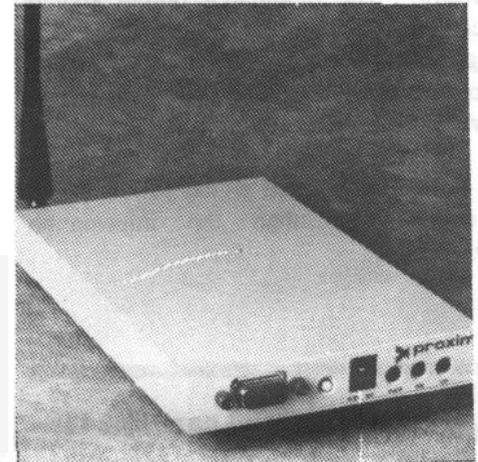


Altair Product Operations, of Motorola, 3209 **Wilke** Road, Arlington Heights, Illinois 60004 - Telephone 1 -800-233-0877, showed a live demonstration of their wireless Altair Plus system at RF EXPO WEST in San Diego, March 18-20. First introduced in 1991, Altair Plus is the first high-speed wireless in-building LAN, providing high-speed communica-

tions between personal computers, file servers, and peripherals.

Named after one of the brightest stars in the universe, the **Altair** wireless LAN appeals to some of the brightest network managers, who are now able to move and change their **ETHERNET LANs** with the workforce they support. **Altair Plus** wireless Ethernet is the second in the growing family of LAN products to be developed throughout the 1990s.

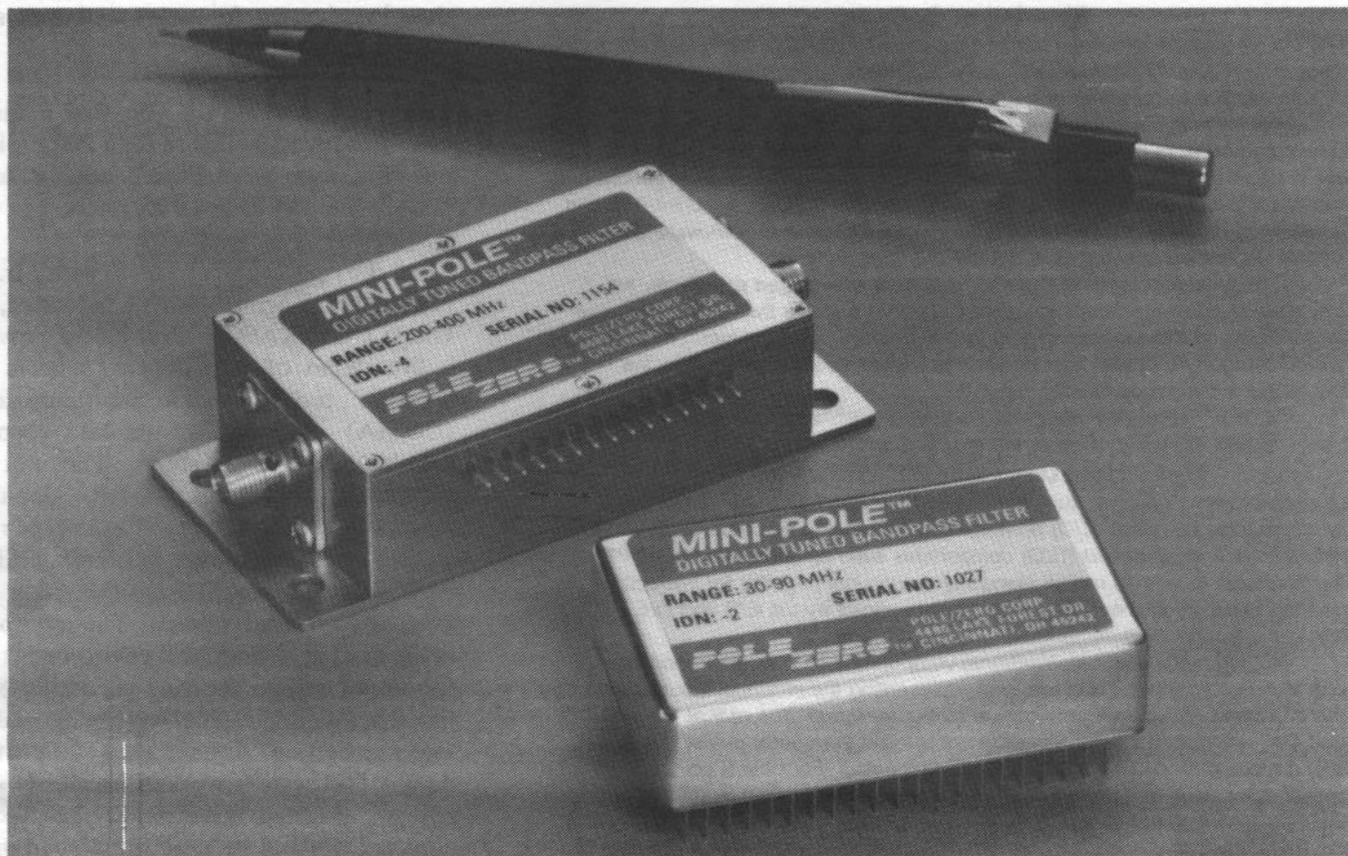
ProxLink Radio Module



Earl McCune, Vice President, of Proxim, 295 North Bernardo, Mountain View, CA 94043 - Telephone 415-960-1630, FAX 415-964-5181 also had a live demonstration at RF EXPO WEST of their **ProxLink** Radio Module. With no cables to install, your RS-232 connection becomes wireless in a few minutes with the un-Licensed **ProxLink**. Using spread spectrum radio and 100% error detection **ProxLink** ensures reliable communication every time. A wide range of baud rates and flow control options can be selected and saved in **ProxLink's** non-volatile memory.

Send Us Your Press Release!

**New Product Information is published free.
Please send camels ready art, however.**



DIGITALLY TUNED RF HOPPING FILTERS AND PRESELECTORS

Pole/Zero Corporation is pleased to announce their newly expanded RF filter and preselector product line. Our **MINI-POLE™** and **MAXI-POLE™** product lines now cover the range from 1.5 - 4, 4 - 10, 10 - 30, 30 - 90, 90 - 200, 200 - 400, 400 - 700 MHz and .7 - 1.0 GHz. The filters are tuned to 251 positions within 10 microseconds across each band and provide 0.5% tuning accuracy from -40 to +85 degrees Celsius. The filters have a wide dynamic range and low intermodulation, with 3rd order intercept performance of +40 dBm. Second order IM performance is +100 dBm. The MINI-POLE and MAXI-POLE are based on POLE/ZERO two pole Butterworth filter designs. Prices start at \$480. Additionally, two RF preselector boards, standard single width PC/AT boards, are now available. One covers the frequency range from 1.5 to 88 MHz and the other covers the wide range from 30 to 700 MHz. They provide the RF system designer with a flexible new digitally tuned preselector for wide dynamic range receivers. The preselector board is compatible with PC/AT computers for ease of control and maximum functionality. Selectivity is very good, with 3 dB bandwidths as low as 3.2% available. The 30 dB bandwidth is as small as 18%, with the ultimate rejection of 80 dB reached at twice the center frequency. Internal amplification allows a 0 dB insertion loss. The noise figure is only 10 dB. Conducted / radiated EMI is limited to less than -130 dBm. Over 1000 tuned frequencies are available via digital bytes. Thus, fast-hop, wide dynamic range, RF receiver systems can be created. Prices for standard preselectors start at \$3900. Custom models are available using any combination of four filters covering the 1.5 MHz to 1 GHz band. For more information contact Joe Janning at (513) 563-1133.

New Products: **SCOPE™** Advanced Optoelectronic and Microwave Circuit Simulation Software

SCOPE™ is a lightwave simulator having total compatibility with the SuperCompact and Microwave Harmonica circuit simulators. SCOPE™-SuperCompact Compatible OptoElectronic Simulator-makes possible for the first time computer-aided design of a wide range of lightwave and microwave circuits. SCOPE™ handles a full range of microwave components as well as a complete range of optoelectronic and optical devices such as lasers and fibers. SCOPE™ allows the efficient design of circuits and subsystems in such lightwave applications as microwave subcarrier multiplexed and cable television systems, phased-array radars, optical control of microwave devices and optical generation of microwave signals.

The present release of SCOPE™ has been developed specifically for intensity modulated directdetection systems. In such systems the RF or microwave baseband signal modulates the intensity or power of an optical carrier. This signal is transmitted through an optical fiber or other optical transmission system to the receiver where the signal is directly detected.

SCOPE™ allows the complete design and optimization of such systems with electrical two port modeling of optoelectronic and optical components.

How Does SCOPE Work?

Lightwave/microwave systems, such as fiber optic analog microwave links, use a variety of electrical to optical (E/O) converters and optical to electrical (O/E) converters as well as all-optical (O/O) components such as optical fiber. SCOPE handles electrical as well as optical signals and accounts properly for interactions between the electrical and optical signals as determined by the E/O and O/E optoelectronic components.

SCOPE models all optoelectronic components such as laser diodes and PIN photo diodes as P-ports with one port representing the electrical input (or output) and the other port representing the optical output (or input). The optical ports of E/O, O/E and O/O components can be interconnected and the optical power transfer between devices is calculated using the voltage 'analog'. For optical components with two optical ports, such as optical fibers, both ports of the two-port model are optical and the input and output powers are both represented by voltage 'analogs'. Optical ports of E/O converters cannot be connected to electrical ports of other devices. The optoelectronics and optical components in SCOPE include models for:

- Laser diodes
- Light-Emitting diodes
- PIN photodiodes
- Optical fibers
- Optical attenuators

Main Features of SCOPE PC DOS, Windows 3.0 or OS/2 Presentation Manager Versions:

SCOPE is available in three formats - DOS, Microsoft Windows 3.0 and OS/2 Presentation Manager. The description that follows refers to the versions operating under the Windows or OS/2 Presentation Manager environments.

SCOPE requires 4 Megabytes of extended memory above the 640K DOS requirement. Memory management is automatic with Windows or OS/2. The program can be run concurrently with other applications provided enough RAM is available. An Intel 386 or 486 computer with at least 4 Megabytes of RAM is recommended. The program uses mouse-driven menus and contains two main windows one for the netlist editor and one for graphics or tabular output. An 'Accumulate Toggle' menu is provided for multiple plots during 'tune' mode.

The PC products include a newly updated and enhanced element library including laser and light emitting diodes, fibers and optical attenuators: fully-correlated complex noise parameters for transistors, Multiple Coupled Lines, Coupler models, arbitrary noise sources, multi-port de-embedding, ideal delay element and time domain simulation.

For further information, please contact: Raymond Penegelly, VP of Marketing and Sales Compact Software, Inc., 483 McLean Blvd. & Corner of 18th Avenue, Paterson, NJ 07504 -- Tel. (201) 881-1200 -- Fax (201) 881-8361.

The Expo was extremely interesting -- several top notch papers were presented and everyone seemed to enjoy the balmy San Diego weather! I ran into many people that I've known for years and met some new faces, too.

This show provided the very first industrial exposure for SSS -- more than 200 copies of our first issue were passed out. A lot of people seemed to have an interest in us!

I had the opportunity to meet with Mr. Phil Karn, Staff Engineer with Qualcomm, San Diego (and KA9Q). Phil kindly provided a live demo of his company's latest and greatest code division multiple access (CDMA) techniques, digital vocoded, cellular telephone system. The unit was installed in Phil's small Japanese automobile -- there was still plenty of room left for passengers, too! Seriously, Phil had a Toshiba laptop 386 in the back seat hooked to the cell-phone. The laptop was being used in a windowed environment with the upper screen showing an oscilloscope-like display of the received signals and the lower screen showing statistics and protocol data. The system worked flawlessly -- of course. We had three nearby cell sites to choose from and they all functioned pretty well -- voice quality adapts automatically to the highest of three available levels.

The Qualcomm (whose partner in the cellular telephone business is Pacific Telesis) system uses very sophisticated SS technology and a lot of custom ASIC's to achieve its high level of performance. Each unit has a built-in GPS receiver for system timing purposes. All units and cells are synchronized to within 1 microsecond of each other, according to Phil. Each Qualcomm SS cell-phone receiver has three separate receiver/processor channels. The outputs of the three separate receiver channels feeds a soft-decision Viterbi decoder. This approach provides very nearly Rake receiver type maximal ratio pre-detection combining and nearly eliminates fading and multipath problems. The Qualcomm system utilizes CDMA and adaptive transmit power control and adapts power levels up to 800 times per second. Wow -- what a system! I want one!

CLASSIFIED ADVERTISING

Classified ads are offered FREE for obviously non-commercial, personal-in-nature advertisers. Commercial classified ads are available at \$50.00 per column inch per insertion. HELP WANTED advertising is FREE if the guidelines established in our April issue are followed, otherwise help wanted ads are available as Display advertising ONLY. Please phone the Publisher for display ad rate information. Enjoy and use this space -- it belongs to you, our subscribers, readers and advertisers.

For Sale: Western Digital WD-1006V, 1:1 RLL HD/FD, 16 Bit, ISA controller, asking \$60; Fujitsu MK134FA-1 42 Meg MFM or 68 Meg RLL 3 1/2 inch Hard Drive, asking \$125; Internal half height 40 Meg Mountain Tape drive, no controller needed / hooks to floppy controller, with three tapes and 3-way cable, asking \$60 -- Randy, KC6YJY, call 415-726-6235

For Sale: Seagate ST-4096 82 Meg MFM or 112 Meg RLL full height Hard Drive, \$150 -- Call Kim, KM6OH, 510-278-9424

Wanted: SSS needs your For Sale, Wanted or any type of personal / business classified advertising. Special reduced rates for business ads will be in effect for June, July and August -- call now with your ad! Don't forget: Personal / non-commercial ads are FREE! Send those ads in -- now!

For Sale: Working 1923 Atwater-Kent Model 10B "Breadboard" Radio, brass base/vacuum tipped 01a's, large 1923 Magnavox dynamic Horn and battery elimin. - \$1500 / ? Randy, 415-726-6235



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